REMARKS

This application has been carefully reviewed in light of the Office Action dated October 2, 2001. Applicant has amended claims 1, 9, 16, 26. Reconsideration and favorable action in this case are respectfully requested.

The Examiner has rejected claims 1-2, 5-9, 12-16 and 19-32 under 35 U.S.C. §101 as being not supported by either a specific asserted utility or a well established utility. As described in detail below, Applicant contends that the claims are fully supported by a specific asserted utility and a well-established utility.

The Examiner has rejected claims 1-2, 5-9, 12-16 and 19-32 under 35 U.S.C. §112, first paragraph, under the reasoning that the invention is supported by either a specific asserted utility or a well established utility and therefore one skilled in the art would not know how to use the invention. As described in detail below, Applicant contends that the claims are fully supported by a specific asserted utility and a well-established utility.

The Examiner has rejected claims 1-2, 5-9, 12-16 and 19-32 under 35 U.S.C. §112, first paragraph, as containing subject matter not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. As described in detail below, Applicant contends that the claims are fully supported in the specification.

The Examiner has rejected claims 1-2, 5-9, 12-15 and 26 under 35 U.S.C. §102(e) as being unpatentable over U.S. Pat. No. 5,907,188 to Nakajima et al. Applicant has reviewed this reference in detail and does not believe that it discloses or makes obvious the invention as claimed.

The Examiner has also rejected claims 20, 21, 23, 27-28 and 29-32 under 35 U.S.C. §103(a) as being unpatentable over Nakajima et al. Claims 16, 24 and 25 stand rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Pat. No. 5,352,620 to Komori

et al in view of Nakajima et al. Claim 19 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Komori et al in view of Nakajima et al and further in view of Wolf, "Silicon Processing for the VSLI Era." Applicant has reviewed these references in detail and does not believe that they disclose or make obvious the invention as claimed.

With regard to the rejection under §101, and the associated rejection under §112, first paragraph, the Examiner argues that the claims are directed to a method of fabricating an electrical device formed in a semiconductor substrate, and having an explosive reaction in the processing chamber would damage the substrate; therefore, utility would be lacking.

The Examiner correctly points to one problem with using an explosive reaction in a semiconductor fabricating process. Another problem would be damage to the semiconductor fabricating equipment. However, these are problems *overcome by the invention.*

The claimed invention provides the capability of oxidizing selected portions of a semiconductor while leaving the conductive structure substantially unoxidized. This capability is of tremendous value in the semiconductor industry. To do so, O_2 and H_2 (or, in certain claims, an oxygen-containing gas and a hydrogen-containing gas) are introduced in an explosive reaction, *such that the reaction between the O_2 and H_2 does not increase the pressure in the processing chamber beyond a predetermined safe level* ("safe" has been added to the independent claims to clarify that the predetermined level is not a dangerous one – this is supported by page 6, lines 18-21). While simply filling the chamber with H_2 and O_2 without regard to chamber pressure and igniting the gases to cause a reaction could result in the type of dangerous situation envisioned by the Examiner, the claimed invention specifies maintaining the pressure below a safe level (as described in detail on page 6, line 18 through page 7, line 16). Thus, the utility of

selective oxidation can be accomplished without danger to either the semiconductor wafer or fabrication devices.

When read as a whole, the present claims provide a very specific and important utility. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection under 35 U.S.C. §101 and the associated rejection under §112

With regard to the second rejection under §112, first paragraph, Applicant disagrees with the Examiner's contention that the "inclusion of the limitation of 'an explosive reaction' between the hydrogen containing gas and the oxygen containing gas is not enabled by the specification and furthermore the process is inoperative."

The specification discusses a reaction between O_2 and H_2 (as well as other embodiments of oxygen-containing gases and hydrogen-containing gases) to produce the selective oxidizing. A reaction between O_2 and H_2 is explosive if the partial pressure is above the explosion limit (the Nakajima reference states that the explosion limit is at a partial pressure of about 4%). Applicant has provided many examples in the specification where one of the gases is set at a partial pressure above the explosion limit. On page 7, a constant volume mix of O_2 and H_2 in a ratio of 1:10 are reacted at an initial pressure of 200 Torr. On page 8 (last paragraph), 12% O_2 and H_2 are introduced into the chamber. On page 11, an O_2/H_2 mixture of 20% is described. All of these reactions are above the explosion limit set by the Examiner's reference (see Nakajima, col.6, lines 24-55).

Despite the explosive reaction, the pressure can be maintained at safe levels using techniques described on page 7, such as by starting at a low chamber pressure, reacting the H_2 and O_2 as the gases enter the chamber, or by starting at a low concentration of one gas and increasing the concentration once the reaction starts, such that the change in pressure is not as dramatic.

Accordingly, the Applicant has provided several examples of gases that have an explosive reaction in the specification. Hence, the terminology used in the claims is fully supported by the specification. Applicant therefore respectfully requests that the rejection under 35 U.S.C. §112 be withdrawn.

With regard to the §102 rejection, the Examiner has provided no reference where an explosive reaction between H_2 (or other hydrogen-containing gas) and O_2 (or other oxygen-containing gas) is used to oxidize selected portions of a semiconductor. The Examiner's remarks concede that "it is noted that in processing explosive reactions are evaded as they are difficult to control and the pressures inside the chambers usually too high."

The invention allows H_2 (or other hydrogen-containing gas) and O_2 (or other oxygen-containing gas), *combined in explosive concentrations,* to be used to oxidize a semiconductor. The higher concentrations provide a thicker oxide layer over the selected areas. Accordingly, it is beneficial to use the higher concentrations.

As referenced above, Nakajima avoids unsafe pressures by using a concentration ratio *below the explosion limit*. Accordingly, the oxidation properties will be lower than those provided by the present invention.

The present invention takes advantage of the superior oxidation properties of using higher partial pressures, while providing safe fabrication, by maintaining a pressure level in the chamber below a safe predetermined level. This is not shown in any of the references cited by the Examiner. It would not be necessary for Nakajima to do so, since the H_2 gas is used in Nakajima at a concentration where it can be considered to be *inert* (Nakajima, col. 6, lines 49-54).

Since Nakajima does not show the use of an explosive reaction while maintaining a safe pressure level in the processing chamber, Applicant respectfully requests allowance of independent claims 1, 9, and 26, and dependent claims 2, 5-8, and 12-15.

Independent claim 16 was rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Pat. No. 5,352,620 to Komori et al in view of Nakajima et al. For reasons stated above, Nakajima does not show the use of an explosive reaction while maintaining a safe pressure level in the processing chamber. The Examiner also cites the Komori reference as using an oxygen-containing gas and a hydrogen containing gas. However, the Examiner correctly stated in the Office Action of October 15, 1999, that Komori did *not* show use of an oxygen-containing gas and a hydrogen containing gas. Applicant believes that Komori was used to show steps in the specific embodiment of fabricating a *capacitor* (Claim 16 and associated dependent claims), but was not intended to show a specific use of an oxygen-containing gas and a hydrogen containing gas in semiconductor fabrication. Applicant has not found any such disclosure in Komori.

For reasons stated above in connection with independent claims 1, 9 and 26, Applicant respectfully requests allowance of claim 16.

The dependent claims provide three different ways in which the explosive reaction of the gases provided by the respective parent claims can be ameliorated. These claims are directed to reducing drastic changes in pressure and provide a significant benefit.

In each case, the Examiner uses the Nakajima reference as teaching the elements of the independent claim. The Examiner concedes that Nakajima does not show increasing the concentration of one of the gases (claims 21, 23, 25 and 28) or increasing the pressure (claims 29-32). The Examiner does not explicitly state whether the references show the subject matter of claims 20, 22, 24, and 27, namely introducing the gases in a portion of a process chamber's total volume, such that the reaction between O_2

and H_2 occurs continuously as the gases enter the chamber; however, Applicant has found no teaching that would suggest the subject matter.

Dependent claims 20, 22, 24 and 27 describe a specific method for maintaining pressure below a predetermined level. Namely, the O_2 (or oxygen containing gas) and H_2 (or hydrogen containing gas) are introduced in a portion of a process chamber's total volume, such that the reaction between O_2 and H_2 occurs continuously as the O_2 and H_2 enter the chamber. Thus, the reaction is confined to a portion of the chamber where the gases react continuously as they enter the chamber. This leaves the rest of the chamber available for expansion, increasing the safety of the process and enlarging the process window.

Since none of the references cited by the Examiner pertain to the use of a combination of gases that have explosive reactions, it would not be obvious from these disclosures that the subject matter of these claims should be used by one skilled in the art.

Claims 21, 23, 25 and 28 describe an additional method of maintaining the pressure of the chamber below a predetermined level. In this case, the O_2 (or oxygen containing gas) and H_2 (or hydrogen containing gas) are introduced in a predetermined ratio, and the concentration of one of the gases is increased after the reaction begins. This technique can be used to minimize the shock of the reaction to the chamber. Once again, the Examiner claims that this method would be in the scope of one of ordinary skill in the art. Again, since none of the references cited by the Examiner pertain to the use of a combination of gases that have explosive reactions, it would not be obvious from these disclosures that the subject matter of these claims should be used by one skilled in the art.

Claims 29-32 describe another alternative method of maintaining the pressure of the chamber below a predetermined level. In this case, the O_2 (or oxygen containing gas) and H_2 (or hydrogen containing gas) are introduced while the chamber is at a low

pressure and increasing the pressure once the reaction begins. This technique can also be used to minimize the shock of the reaction to the chamber. Since none of the references cited by the Examiner pertain to the use of a combination of gases that have explosive reactions, it would not be obvious from these disclosures that the subject matter of these claims should be used by one skilled in the art.

The Commissioner is hereby authorized to charge any fees or credit any overpayment, including extension fees, to Deposit Account No. 01-1615 of Anderson, Levine & Lintel, L.L.P.

Applicants have made a diligent effort to place the claims in condition for allowance. However, should there remain unresolved issues that require adverse action, it is respectfully requested that the Examiner telephone Alan W. Lintel, Applicants' Attorney at (972) 664-9595 so that such issues may be resolved as expeditiously as possible.

For these reasons, and in view of the above amendments, this application is now considered to be in condition for allowance and such action is earnestly solicited.

Respectfully Submitted,

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February 4, 2002
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Version with marking to show changes made:

1 (Four Times Amended). A method of fabricating, in a semiconductor processing chamber, an electrical device formed in a semiconductor substrate, said method comprising:

forming an insulating layer over said semiconductor substrate;

forming a silicon-containing structure on said insulating layer;

forming a conductive structure on said silicon-containing structure; and

oxidizing a portion of said insulating layer and said silicon-containing structure while leaving said conductive structure substantially unoxidized by introducing O_2 and H_2 in an explosive reaction to said insulating layer, said silicon-containing structure and said conductive structure, such that the reaction between said O_2 and H_2 does not increase the pressure in the processing chamber beyond a predetermined <u>safe</u> level.

9 (Four Times Amended). A method of oxidizing, in a semiconductor processing chamber, a first feature while leaving a second feature substantially unoxidized, said method comprised of subjecting said first and second features to O_2 and H_2 in an explosive reaction, such that the reaction between said O_2 and H_2 does not increase the pressure in the processing chamber beyond a predetermined <u>safe</u> level.

16 (Four Times Amended). A method of fabricating, in a semiconductor processing chamber, a capacitor having a dielectric between a bottom electrode and a top electrode and situated over a semiconductor substrate, said method comprising the steps of:

providing said bottom electrode over said semiconductor substrate;

providing a dielectric material over said bottom electrode; and

subjecting said bottom electrode and said dielectric material to O_2 and H_2 in an explosive reaction, wherein said dielectric material is oxidized and said bottom electrode remains substantially unoxidized, such that the reaction between said O_2 and

H_2 does not increase the pressure in the processing chamber beyond a predetermined safe level.

26 (Thrice Amended). A method of fabricating an electrical device formed in a semiconductor substrate, said method comprising:

forming an insulating layer over said semiconductor substrate;

forming a silicon-containing structure on said insulating layer;

forming a conductive structure on said silicon-containing structure; and

oxidizing a portion of said insulating layer and said silicon-containing structure while leaving said conductive structure substantially unoxidized by introducing an oxygen-containing gas selected from the group consisting of O_2, N_2O, NO or CO_2 and a separate hydrogen-containing gas to said insulating layer, said silicon-containing structure and said conductive structure, such that an explosive reaction between said the hydrogen-containing gas and the oxygen containing gas does not increase the pressure in the processing chamber beyond a predetermined safe level.